Heat Post-Treatment to Reduce Thickness Swelling of Particleboard from Fast-Growing Poplars

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Abstract According to the high thickness swelling and low dimensional stability of Poplars particleboard, this paper studied the effect of heat post-treatment on the board properties. The results indicated that the post-treatment could be a very effective way to produce dimensinaly stable fast-growing poplars particleboard. The thickness swelling of the board decreased with increasing the time and temperatures of post-heat treatment. So under190 ℃, being treated for 15 min., the total thickness swelling (TS_1) of the board was 8.96%, reduced by 22.88%. The irreversible thickness swelling (TS_2) was also reduced with the post-treatment of 190 ℃ or 220 ℃; The reversible thickness swelling (TS_3) was not signifcantly changed when the time of treatment increased up to 25 min. under 190 ℃.

Key words: Heat post-treatment, Thickness swelling, Particleboard

Introduction

In recent years, particleboard has been used more and more widely, It is not only used for furniture manufacturing and interior decorating but also as exterior building material. Because of the changes of the surrounding atmosphere, the variation in moisture content of particleboard results in a low dimensional stability. If the dimensional stability of particleboard is poor, the alternative movement of thickness swelling and shrinking can impair the internal bond of the board, thus decrease the strength and durbility. So, particleboard used outside must be highly dimensionally stable. The fast-growing Poplars have a high proportion of young growth wood which features low strength, big cell cavity, high content of gum fiber (Panshin 1986, Smith 1986, Qinag Shi 1991). Therefor the particleboard made from it would result in a poor dimensional stability.

The method of heat-tratment for the particleboard was put forword by Suchsland and Enlow (1968) to improve its water resistance and dimensional stability. They thought that the compression stress in board could be released and thickness swelling could be diminished by the method. Heebink (1969) treated the particleboard by using saturation steam at 149 °C, 166°C or 182°C for 10 minites, he found that the treatment was remarkably effective on decreasing thickness swelling. Talor (1987) testified by his experiment that the dimensional stability of wood-based panel could be greatly improved by treating particles under high presure steam.

Materials and methods

In regard to the particleboard preparation please refer to the related study (Study on The Tannin-Based Adhesive Particleboard From Fast-Growing Poplars).

The board was bounded with the PF-1 low toxicity phenol-formaldehyde resin.

The waterproof agents was DTL-2 with the consistency 50%.

The targeted board's specific gravity (SG) was 0.70 g/cm^3, and its thickness was 12 mm. All the test procedures and required numbers of speciments followed what are outlined in Germany Standard DIN 68763 V100. Acoording to the referencees, good effects of treament can be got if the temperature is above 220 ℃, but the post-heat treatment had to be carried out by existing press, so the treatment condition was defined that under 190°C and the treatment time was 5 min, 10 min, 15 min, 20 min or 25 min. The treatment temperature of 220°C (5 min, 10 min.) was used for comparision. The practical methods: the particleboard was made under the following conditions (press temperature 190°C, press time 10 min, resin content 10 %, waterproof agent content 2.5%), then the manufacturded board was treated in the press under the temperature 190°C or 220°C in other press under zero pressure).

Results and discussion

The method of post-heat treatment could improve the

dimensional stability of particleboard (see Table 1 and Fig.1). The total thickness swelling (TS_1) of particleboard was reduced after the treatment under temperature of 190 ℃ or 220 ℃. Under 190 ℃, the TS_1 was reduced rapidly with increasing the treatment time to 10 min., and reduced continuouly with a low rate when the time increasing further up to 25 min.. The TS_1 was reduced by an average of 8.75% per minute when treatment time up to 10 min., but it was 2.89% per minute when time increased from 15 min. to 25 min.. So under 190 ℃, the treatment time of 15 min. was approriate. The TS_1 of particleboard under this condition was 8.96%, reduced by 22.88%.

Table 1. Thickness swelling of treated particleboard

Sample No.	1	2	3	4	5	6	7	8
	(0 min.)	(5 min.)	(10 min.)	(15 min.)	(20 min.)	(25 min.)	(5 min.)	(10 min.)
TS_1,%	11.01	10.14	9.37	8.96	8.67	8.47	8.91	8.26
TS_2,%	6.47	5.83	5.15	4.71	4.44	4.18	4.98	4.02
TS_3,%	4.29	4.29	4.20	4.19	4.18	4.21	4.16	3.93
TS_4,%	23.63	22.35	20.75	19.96	19.15	18.84	19.64	18.74

Note: No.1-6 are the results of 190 ℃; No.7-8 are the results of 220 ℃; TS_1 is the tatol thickness swelling; TS_2 is irreversible thickness swelling; TS_3 is reversible thickness swelling; TS_4 is the thickness swelling of the particleboard soaked in the hot water for 2 hours

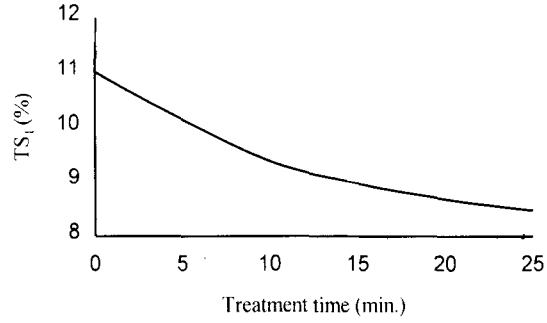

Fig.1. The thickness swelling (TS_1) of the board with the various of treatment time

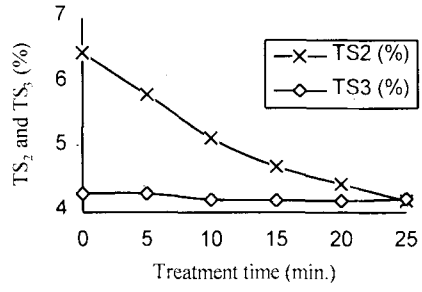

Fig. 2. The thickness swelling (TS_2 and TS_3) of the board with the various treatment time

Additionally the rusults indicated that the TS_1 of the particleboard treated for 5 min. under 220 ℃ was as same as that treated for 15 min. under 190 ℃, the TS_1 of the particleboard treated for 10 min. under 220 ℃ was lower than that treated for 25 min. under 190 ℃. This shows that the dimensional stability was good for board treated under high treatment temperature, but at a lower temperature, the good dimensional stability also could be obtained if the heat treatment time was prolonged.

The Table 1 and Fig. 2 shows that the irreversible thickness swelling (TS_2) of particleboard was also reduced when increasing treatment time after post-treatment of 190 ℃ or 220 ℃. This indicated that the post-treatment could minimize the built-up of internal stresses in the board, thus the spring back of compressed (densified) wood and the breakage of adhesive bond between wood particles would be reduced, and so was the TS_2.

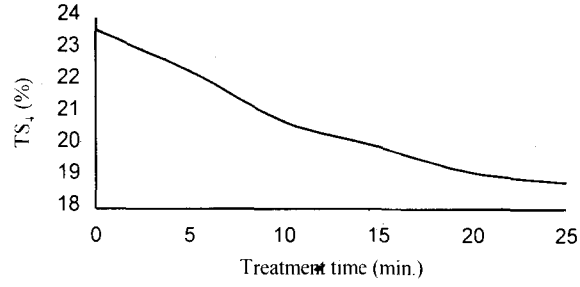

Fig. 3. The thickness swelling (TS_4) of the board with the various of treatment time

The reversible thickness swelling (TS_3) was insignifcantly changed when treatment time increased to 25min under 190 ℃, while under 220 ℃ the reversible thickness swelling (TS_3) was reduced certainly. This shows that the high treatment temperature could improve the hygroscopic nature of wood, so the TS_3 was reduced.

The Table 1 and Fig.3 shows that the thickness swelling of the particleboard soaked in the hot water for 2hours (TS_4) was also reduced after heat-treatment, and the reducing rate was great when increasing the treat-

ment time. This shows that the post-heat treatment could improve the dimensional stability of particleboard even after soaking in hot water.

Conclusions

The results of this study illustrated that the post-treatment for manufatured panel could be a very effective way to improve dimensinal stability of fast-growing poplars particleboard. The total thickness swelling (TS_1) of particleboard decreased with increasing the time and temperature of post-heat treatment. The TS_1 of particleboard was reduced by 22.88% when treatment time was 15 min. under 190 ℃. The irreversible thickness swelling (TS_2) of particleboard was also reduced when increasing treatment time under post-treatment of 190 ℃ or 220 ℃; The reversible thickness swelling (TS_3) was not signifcantly changed when treatment time was up to 25 min. under 190 ℃.

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